

Types of Sensations

Definition:

- Sensation is the feeling produced by change in the environment or by the application of stimulus to the receptors, or nervous pathways.

Classification:

Anatomical classification (According to the site of sensation):

I- Emotional sensations:

- They include: sadness, fear, pleasure..... etc.

II- Special sensations:

- Its receptors are localized to certain organ or area in the body.
- They include: vision, hearing, taste & smell.

III- General sensations:

- Its receptors are widely distributed all over the body.
- It is divided into:

A) Organic sensations:

- They include: thirst, hunger & sexual desire.

B) Visceral sensations:

- These sensations arising from the viscera & walls of blood vessels.
- They include: visceral pain, temperature..... etc.

C) Somatic sensations:

- These sensations arising from skin and deeper structures e.g. skeletal muscles, tendons, ligaments, joints and periosteum.
- It is further subdivided into:
 - Superficial sensations:
 - It is also called cutaneous (= skin) sensations.
 - These sensations arising from skin.
 - They include: cutaneous pain, touch & temperature.
 - Deep sensations:
 - These sensations arising from deep structures e.g. skeletal muscles, tendons, ligaments, joints.
 - They include: deep pain, pressure sense, muscle sense & proprioceptive sensations.
 - Combined (= mixed) sensations:
 - They include: vibration sense & stereognosis.

Physiological classification (According to the modality [= type] of sensation):

I- Mechano-receptive sensations:

- They include:
 - 1) Touch sensation:
 - a- Crude touch.
 - b- Fine touch, which further subdivided into:
 - Tactile localization.
 - Tactile discrimination.
 - Stereognosis.
 - Texture of materials.
 - 2) Pressure sense.
 - 3) Muscle tension sense.
 - 4) Tickle & itch sensations.
 - 5) Vibration sense.
 - 6) Proprioceptive (= kinesthetic) sensations:
 - a- Static sensation (= sense of position).
 - b- Dynamic sensation (= sense of movement).

II- Thermo-receptive sensations:

- Sensation of temperature (hot & cold)

III- Pain sensation:

- It include:
 - 1) Cutaneous.
 - 2) Deep.
 - 3) Visceral.

Mechano-receptive Sensations

I- Touch Sensation:

Definition:

- It is the ability to detect contact of the body with any object.
- It is a cutaneous sensation produced by light mechanical pressure causing deformity of the skin or tilting the skin hairs.

Types:

- a) Crude (or light, rough) touch.
b) Fine touch

	Crude Touch	Fine Touch
Definition	It is touch sensation with poor identification of site and number of stimuli.	It is touch sensation with accurate identification of sites and number of stimuli.
Character	- Protopathic sensation. - Poorly localized.	- Epicretic sensation. - Well localized.
<u>Receptors:</u>		
> Name	1. Free nerve endings. 2. Hair end organs.	1. Meissners's corpuscles. 2. Merkel's discs. 3. Pacinian corpuscles. 4. Ruffini's endings.
> Site	- Present in the skin. - <u>More in:</u> <ul style="list-style-type: none"> Finger tips & lips. Proximal than distal. Hairy area. 	
> Type	Mechano-receptors	
> Mechanism of stimulation	- Tissue displacement. - Tissue deformity.	
> Adaptation	Rapidly adapting	
Afferent Nerve	A δ & C	A β
Tract	Ventral spinothalamiic	Dorsal column
Center for perception	Thalamus	Cortex
Examination	Stocking the skin lightly by a piece of cotton (cotton wool test)	According to type

Subtypes of Fine Touch:

a) Tactile Localization (or Topognosis)

- > Definition:

- It is the ability to localize a touched cutaneous spot while the eyes are closed.

➤ Examination:

- 2-markers test.

b) Tactile (or 2-point) Discrimination (TD)

➤ Definition:

- It is the ability to perceive, with eyes closed, two touch stimuli applied to the skin at the same time as two separate points of touch.
- This required that distance between these 2 points is more than the threshold distance.

➤ Threshold distance:

- It is the minimal distance between 2 touched points to be felt as 2 separate points.
- It is variable in different areas of the body.
- The shorter the threshold distance, the more acute tactile discrimination.
- Tactile discrimination is more acute in areas having least threshold distance.
- Threshold distance:
 - Finger tips & lips = 2–3 mm (maximum acuity).
 - Hands & arms = 5–6 mm.
 - Trunk, shoulders & thighs = 5–6 cm (least acuity).

➤ Factors affecting the acuity of tactile discrimination:

1. Number of receptors in this area (the more dense receptors → more acute).
2. Number of afferent sensory nerves (the more dense → more acute).
3. Presence of convergence in the sensory pathway (the less convergence → more acute).
4. Area of representation in the sensory cortex (the wide representation → more acute).

➤ Examination:

- Touching the skin with the 2-blunt points of a Weber's compass.

Stereognosis

➤ Definition:

- It is the ability to identify *familiar* objects by handling it while eyes are closed.
- The object is identified from its shape-size (by touch) and weight (by pressure).
- It is a mixed (= combined) sensation depending on both touch & pressure.

- It is a highly educated sensation that requires the integrity of the higher cortical sensory areas.

➤ Requirements:

- Intact all sensations.
- Previous cortical experience, that why we should use familiar object.

➤ Examination:

- Giving the patient familiar object (e.g. key, pen or coin).
- Loss of this sensation is called "Astereognosis".

c) Texture of material

➤ Definition:

- It is the ability to know the texture of different material (e.g. silk, wool, cotton) with the eyes closed.
- It is a type of stereognosis.

➤ Examination:

- Giving the patient a piece of cloth and asking him to identify its nature.

II-Pressure Sensation:

Definition:

- This sensation enables the person to know the weight of objects and discriminate between different weights without lifting them.
- Pressure sense doesn't enable the subject to know whether the object is rough or with sharp edges, it enables him to know that there is a weight pressing on his hand.

Receptors:

➤ Name:

- Pacinian corpuscles.
- Ruffini's endings.

➤ Site:

- Skin & subcutaneous tissues.

➤ Type:

- Mechano-receptors.

➤ Mechanism of stimulation:

- Tissue displacement.

- Tissue deformity.

Afferent nerve:

- A β fibers.

Ascending tract:

- Dorsal column tract.

Center for perception:

- Cerebral cortex.

Examination:

- Placing different weights on the patient's hand while supported on a table.

III- Muscle Tension Sensation:

Definition:

- This sensation enables the person to know the weight of objects and discriminate between different weights during lifting them.
- It is the sensation evoked by traction on the tendons.

Receptors:

- Name:
 - Golgi tendon organs.
- Site:
 - Tendons of the muscles.
- Type:
 - Mechano-receptors.
- Mechanism of stimulation:
 - Tissue displacement.
 - Tissue deformity.

Afferent nerve:

- A β fibers.

Ascending tract:

- Dorsal column tract.

Center for perception:

- Cerebral cortex.

Examination:

- Asking the patient to differentiate between various weights placed in the unsupported hand.

IV- Tickle & Itch Sensation:**Definition:**✓ Tickle:

- It is a pleasurable sensation, often causing laugh.
- It results from mild tactile (e.g. light moving thing) stimulation of the skin.

✓ Itch:

- It is an annoying sensation.
- It results from skin irritation by:
 - Moving tactile stimuli (e.g. crawling flea).
 - Certain chemical substances released (e.g. histamine in allergic conditions).
- It often initiates the scratch reflex which helps removal of the stimulus.

Receptors:➤ Name:

- Free nerve endings.

➤ Site:

- Superficial layer of the skin.
- Itch may also occur in the eyes & some mucous membranes, but not in the deep tissues or viscera.

➤ Type:

- Mechano-receptors.

➤ Mechanism of stimulation:

- Tissue displacement.
- Tissue deformity.

Afferent nerve:

- C fibers.

Ascending tract:

- Ventral spinothalamic tract.

Center for perception:

- Thalamus.

V-Vibration Sense:**Definition:**

- It is the sense of thrill (or buzzing).
- It is a rhythmic sensation.
- It results from rapid repetitive tactile stimulation.

Receptors:➤ Name:

- Meissners's corpuscles (respond to frequency up 80 cycle/sec "Hertz").
- Pacinian corpuscles (respond to frequency up 500 cycle/sec "Hertz").

➤ Site:

- Both skin & subcutaneous tissues.

➤ Type:

- Mechano-receptors.

➤ Mechanism of stimulation:

- Tissue displacement.
- Tissue deformity.

➤ Adaptation:

- The receptors are rapidly adapting, but the sense itself is non-adapting.

Afferent nerve:

- Aβ fibers.

Ascending tract:

- Dorsal column tract.

Center for perception:

- Cerebral cortex.

Examination:

- Placement of the base of a vibrating tuning fork on a bony prominence of the body of a person with closed eyes.
- There are no receptors in the bone for vibration, but bone magnifies the vibration to be perceived by the receptors.
- Vibration sense could be examined over bony prominence (= subcutaneous bone) anywhere in the body, Except the head (**why?**).
- This sensation is very important to be tested to diagnose the early lesion of dorsal column tract, as it is the first sensation to be lost.

VI- Proprioceptive Sensation:

Definition:

- It is also called "Kinesthetic" sensations.
- It is the conscious perception of orientation of the various parts of the body in space and relative to each other.

Types:

- Static proprioception (sense of position).
- Dynamic proprioception (sense of movement).

	Sense of Position	Sense of Movement
Definition	It is the sensation of the position of different parts of the body in space & with respect to each other.	It is the sensation of movement of joints.
Character	- Static type.	- Dynamic type.
<u>Receptors:</u>		
> Name	1. Ruffini's endings. 2. Golgi tendon organs. 3. Muscle spindles.	1. Pacinian corpuscles.
> Site	<u>Found in deep structures:</u> <ul style="list-style-type: none"> ▪ Muscles. ▪ Tendons. ▪ Ligaments. ▪ Tissues around ligaments. ▪ Joint capsules. 	

➤ Type	Mechano-receptors	
➤ Mechanism of stimulation	- Tissue displacement. - Tissue deformity.	
➤ Adaptation	Slowly adapting	Rapidly adapting
Afferent Nerve	A β	
Tract	Dorsal column	
Center for perception	Cortex	
Examination	Putting a limb (finger or toe) in a special position and ask the patient to identify the position.	Moving a limb (finger or toe) passively and ask the patient to describe the movement.

Ascending Sensory Tracts

Definitions:

Tract:

- It is a bundle of nerve fibers in the spinal cord with common origin, termination and function.

Sensory tract:

- It is a tract which conducts sensory signals in the spinal cord up to higher brain centers.

Order neuron:

- It is a synapse in the sensory pathway.

Sensory pathway:

- Represents the pathway of a certain sensation starting from the afferent nerve connected to a specific receptor till the termination in the cerebral cortex.
- The sensory pathway is given different names along its way in the CNS; as follows:
 - a) In the spinal cord →→→ Tract.
 - b) In the brain stem →→→ Lemniscus.
 - c) In the cerebral cortex →→→ Radiation.

The Sensory Pathways (Ascending Tracts)

Classification:

- I- SpinoThalamic (= Antero-Lateral) system.
- II- Dorsal (= Posterior) Column system.
- III-Spino-Cerebellar tracts.

Characteristics:

All the ascending sensory pathways have the following characteristics:

- a) All of them are formed of 3-order neurons.
- b) All of them have their first (1st) order neuron in the **Dorsal Root Ganglion (DRG)**.
- c) All the tract that carry conscious sensation cross to the other side along their pathway:
 - Sensations from the left side of the body reach the right sensory cortex, and vice versa.
 - The axons that cross to the opposite side are that of the second (2nd) order neuron.

- d) All somatic sensations relay in the thalamus before reaching the thalamus, except unconscious proprioceptive sensations.

SpinoThalamic (= Antro-Lateral) System

Functions:

It transmits the following sensations:

- a) Pain.
- b) Temperature.
- c) Crude touch.
- d) Itch & tickle.

Nerve Fibers:

It contains 2 types of nerve fibers ($A\delta$ & C).

Characteristics:

1. It is a slowly conducting system (made up of thin $A\delta$ & C fibers).
2. Poor localization of sensations & intensity discrimination.
3. Can't transmit rapid repetitive signals.

Divisions:

It is divided into 2 tracts:

- I- Ventral SpinoThalamic (VST) tract.
- II- Lateral SpinoThalamic (LST) tract, which is further subdivided into:
 - a) Neospinothalamic tract.
 - b) Paleospinothalamic tract.

Dorsal (= Posterior) Column System

Functions:

It transmits the following sensations:

- a) Fine touch (including: tactile localization, tactile discrimination, stereognosis & texture of material).
- b) Pressure.
- c) Muscle tension.
- d) Vibration.
- e) Conscious Proprioception.

Nerve Fibers:

It contains only one type of nerve fibers (A β).

Characteristics:

1. It is a rapidly conducting system (made up of thick, myelinated A β fibers).
2. High degree of localization of sensations & intensity discrimination.
3. Transmit fine sensations.
4. Transmit rapid repetitive signals.

Divisions:

It is divided into 2 tracts:

- I- Gracile tract.
- II- Cuneate tract.

Spino-Cerebellar Tracts

Functions:

It transmits unconscious proprioceptive sensations to the cerebellum.

Nerve Fibers:

It contains only one type of nerve fibers ($A\beta$).

Characteristics:

1. It is a rapidly conducting system (made up of thick, myelinated $A\beta$ fibers).
2. These tracts don't reach the cerebral cortex.

Divisions:

It is divided into 2 tracts:

- I- Dorsal Spino-Cerebellar tract.
- II- Ventral Spino-Cerebellar tract.

Somatic Sensation from the Head

Back of the Head:

- It is the area of the posterior part of the head behind a line passing through the vertex.
- Sensations are carried by the afferent fibers of the 2nd & 3rd cervical nerves.
- The sensations are transmitted along the ascending sensory pathways according to their type (similar to the sensations carried from the body as discussed before).

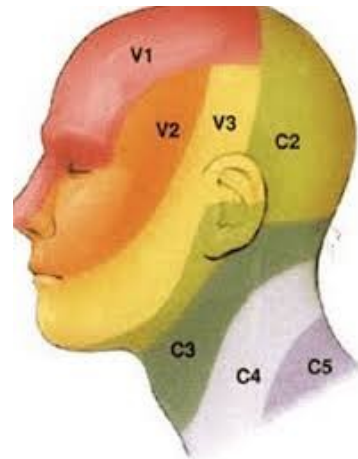
Front of the Head:

- Sensations from anterior part of the head (= the face) are carried by the 5th cranial nerve (= Trigeminal nerve, CN V).
- Trigeminal nerve has 3 branches:

I- Ophthalmic (V1):

It transmits sensation from:

- Upper part of the face:
- Forehead.
- Anterior part of the scalp.
- Cornea.
- Conjunctiva.
- Nasal mucosa.



II- Maxillary (V2):

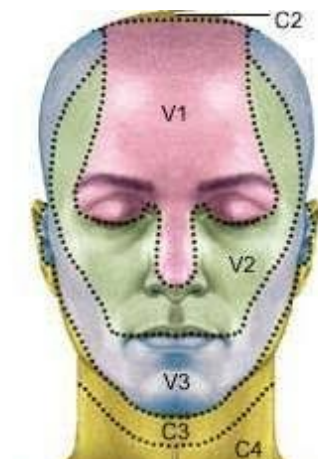
It transmits sensation from:

- Middle part of the face.
- Hard palate.
- Upper teeth & gums.

III- Mandibular (V3):

It transmits sensation from:

- Lower part of the face.
- Lower teeth & gums.
- Anterior 2/3 of the tongue.
- Nasal mucosa.



👉 **Compare the pathways of the different ascending sensory tracts.**

	SpinoThalamic Tracts		Dorsal Column Tracts	Spino-Cerebellar Tracts	Trigeminal Pathway
	VST	LST			
1st order neuron	<ul style="list-style-type: none"> - Cell bodies present in DRG. - Terminate in dorsal horn of spinal cord 		<ul style="list-style-type: none"> - Cell bodies present in DRG. - Terminate in medulla oblongata 	<ul style="list-style-type: none"> - Cell bodies present in DRG. - Terminate in dorsal horn of spinal cord 	<ul style="list-style-type: none"> - Cell bodies present in trigeminal ganglion. - Terminate in 3 different sensory nuclei.
2nd order neuron	<ul style="list-style-type: none"> - Arise from dorsal horn of spinal cord, from the Main Sensory Nucleus (MSN) - Terminate in the thalamus. 	<ul style="list-style-type: none"> - Arise from dorsal horn of spinal cord, from the Substantia Gelatinosa of Rolandi (SGR). - Terminate in the thalamus (<u>Except?</u>). 	<ul style="list-style-type: none"> - Arise from Gracile & Cuneate nuclei in medulla oblongata. - Terminate in the thalamus. 	<ul style="list-style-type: none"> - Arise from dorsal horn of spinal cord, from Clark's nucleus. - Terminate in the deep cerebellar nuclei. 	<ul style="list-style-type: none"> - Arise from the 3 different sensory nuclei: Main Sensory Nucleus, Mesencephalic & Spinal Nucleus. - Terminate in the thalamus.
3rd order neuron	<ul style="list-style-type: none"> - Arise from PostroVento-Lateral Nucleus (PVLN) of thalamus. - Terminate in cerebral cortex (sensory area in posterior central gyrus). 			<ul style="list-style-type: none"> - Arise from deep cerebellar nuclei. - Terminate in cerebellral cortex. 	<ul style="list-style-type: none"> - Arise from PVMN of thalamus. - Terminate in cerebral cortex